Chap. 12 : vocational education and development (part ii. case-studies)

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Vocational Education and Development

Despite the efforts undertaken by developing countries to build their manpower, success often has not come as readily as expected (however, it is often said that the effect of development has been excellent in education and the military in comparison with other fields.) Consequently, of particular interest in the Japanese experience has been the question of education.

An ILO document pointed out as early as 1966 that "any success in industrial development depends, to a certain extent, on the possibility of utilization of skills. The productivity of a plant or facility will be low if the ability of its management or workers is low. In such a case, domestic investment will provide no assistance to development, but become a burden to a very poor society."[49]

The current situation of an abundance of unskilled workers or the incomplete utilization of them indicates there are problems of national efforts and international co-operation in both the development of ability (education) and the manner of utilization (administration).

The solution to the manpower problems facing developing countries does not rest exclusively with the formation of industrial manpower; indeed, the formation of manpower in this way is not recommendable. Nevertheless, it is true that the formation of industrial manpower is currently an important and urgent problem.

Development and an educational system in support of it have, at times, given rise to campaigns of opposition. Not long ago in India, for example, a campaign against central-government-controlled education achieved widespread support.

Education is necessary for development, but when efforts to promote development and education run up against opposition, a social and national consensus cannot be formed, or any that may be formed or that already exists can be destroyed, throwing development and education into confusion.

Such problems have been experienced in Japan. There was not nation-

wide support for or a consensus over all facets of "modernization from above," the initiative for which was taken by the government. Often, the opposition to institutionalized education (and its quality), for example, resulted in riots.

In Tsuruga, central Honshu, for instance, followers of a certain sect of Buddhism rioted in demand of restoration of preaching by the sect, rejection of Christianity, and discontinuation of the teaching of Western-style writing. This was in 1873. In the following year, farmers in Okayama Prefecture rioted in protest of formal education, and 46 elementary schools were destroyed; the farmers were also demanding the abolition of conscription. In Tottori Prefecture, 10,000 farmers rose up against schools, conscription, and the Western calendar. Similar riots occurred in Kagawa and Fukuoka prefectures, where 34 and 29 schools were burned.

All these riots took place in the year following the initiation of the national educational system, and "opposition campaigns continued for several years after that" (Nagai 1969).

The school system proclamation of 1872—which "aims to realize, whether commoners, nobles, samurai, farmers, craftsmen, merchants, or women, education for every family in every town and every member of every family"—was a declaration of equal-opportunity and compulsory education for all. According to the plan, the whole country was divided into 8 university districts, each of which was divided into 32 middle school districts, and each of these into 210 primary school districts, with one primary school in each. The primary schools were to be divided into higher and lower, each with a 4-year curriculum.

The plan was more democratic and ambitious than the system in France of 70 years later. However, the lack of full financial backing by the central government created a heavy burden for the inhabitants of each of the various districts when the time came to set up the new schools. Under such circumstances, the hardship (in figures amounting to about 8 per cent of their average annual income) induced the sort of riots mentioned above. The government was able to take care of only two-thirds of the necessary expenses, and it halved the budget for the second fiscal year.

Consequently, seven years after the plan was initiated, the education system was reformed under the Education Order of 1879. The French aspects of the system were abandoned, and a system modeled on the US system was introduced.

The new system reflected the effects of the Freedom and People's Rights Movement, a nation-wide political movement of the early Meiji period involving former samurai and commoners whose aim was to reform the new government along western democratic lines. The centralized and conformist nature of the earlier system was changed, and it became possible to establish private schools. As a result, the number of schools increased, but the quality of education fell and school attendance dropped. In this way, "the Education Order went bankrupt as soon as it was promulgated" (Nagai 1969).

When Westernization of education in pursuit of rapid modernization was

being forced to retreat, a group loyal to the Imperial Court initiated a movement aimed at reforming education by restoring the national tradition. This led to a confrontation between the Imperial Court and the government. The dispute had a decisive and long-lasting effect on the course of Japanese education.

Thus, the oft-heard belief that the Japanese success in industrialization and modernization was all thanks to the successes in education is an oversimplification. Neither education nor industrial technology has ever progressed in a straight line, and both have usually had to advance along tortuous routes.

Recognition of the success of Japanese education must not neglect the role of the military in education, especially its dissemination of the technology of machine operation and its role in teaching the concepts of hygiene and punctuality. Acknowledging its positive role does not, of course, represent a denial of its negative aspects. In addition to the military, the role of vocational and technical education, which took place not in the schoolroom but at the production site, was also critical.

Typical of this on-site educational process is the practice of rotating engineers, for example, from the research and development department to the shop-floor and back again; this practice reflects the importance attached not only to the basic science but also to the practical aspects of a technology that must be considered if operation and productivity are to prove efficient.

In the early stages of educational standardization, technical education was not included in the national education system integrated under the Ministry of Education. Each ministry had its own policy and organization to cultivate manpower for technology transfer. Vestiges of this can be seen even today in the Tokyo University of Fisheries, under the control of the Ministry of Agriculture and Fisheries, and the merchant marine colleges, under the Ministry of Communication and Transportation.

The Ministry of Education was established in 1871, which, it might be noted, followed by just a year the introduction in Great Britain of the compulsory education system on a nation-wide scale. At the time, vocational education and ordinary education were separate systems in Japan.

Despite this lack of a unified education system, however, each was successful in absorbing and disseminating new knowledge and theories. Indeed, a segment of the population had attained a certain level of education, although only a select few. The seeds had been sown; it was necessary to spread elementary education to encourage growth and maturity. Throughout this process, the principle of attaching importance to the production site in vocational education was maintained. After much time, an integrated national education system was established, one reflecting the evolving needs of national development. In the course of its establishment, there have been immense and diverse technological changes, and it has now become necessary for the entire system, from primary school to the university (including postgraduate courses), to meet the needs of the high degree of basic scientific knowledge required in the face of rapid innovation in technology and en-

gineering. Thus, in Japan the seriousness of the issue of education is fundamentally the same as in developing countries; the only difference is in the form and circumstances of the problem.

Japanese Modernization and Education—Take-off and Fall

Needless to say, those educated at public expense should, ideally, contribute, in return, to fulfilling the needs of society in a manner and degree that befits their education. And indeed, in the early years of the Meiji period, this goal was satisfactorily realized. The foreign scholars, engineers, and specialists employed by the government and private companies at great expense were able to be replaced in a relatively short time by Japanese who had received training and education abroad. The students sent abroad felt themselves to be an élite group; they possessed a keen sense of patriotic duty and responsibility. It was fortunate that education in science and engineering had been institutionalized in the West since the middle of the previous century; the timing could not have been better. This was particularly so with regard to Germany, where a number of students sought training at some universities there. A late comer in western Europe compared with Great Britain and France, Germany at the time was entering the industrial revolution, and its engineering science—rooted in national culture—was attracting the attention of other nations. It was lucky for Japan, an even later entrant than Germany, to be able to learn from the experiences of a late comer.[50]

The technology then was simpler than today's. It consisted of combinations of skills, and once the principle of integrating them had been mastered, the only obstacle remaining was to establish links within and outside each specific technology. Japan's traditional technologies and the necessary resources were at hand, and a national consensus and government policy for development were stable. Yet, despite these favourable conditions, it took more than half a century to establish even a basic system of national technology. Nevertheless, Japan's experiences seem to show that international co-operation is important for creating an independent national technology.

The darker side of educational development at this time was the emergence of a nationalisic bent. Isolated from the rest of the world, Japan grew into an imperialistic nation. The Meiji education system was controlled by the government, which moulded it to suit its nationalistic aims at the sacrifice of the cultivation of humanity and talent. In fact, in the nature of the "splendid take-off" educational development experienced were the seeds for its "fall" (Nagai 1969). How this was so should become clearer as our discussion progresses.

Despite the government's manipulation of education, technical and vocational education continued to progress. Science and engineering, by virtue of their rational, logical nature, were protected from the "supralogical" state religion of Shinto. Perhaps for this reason, students from Korea and Taiwan, then colonies of Japan, chose to study these subjects. Many such students

studied medical science because the big companies had not yet opened their doors to them, even though they had graduated with degrees in engineering and science, and it was easier to set up practice as an independent medical doctor.

The Meiji government was confronted with the problem of the revision of the unequal treaties with the Western powers. It was also being challenged by the growing activity of the Freedom and People's Rights Movement, which was demanding greater freedom to participate in national politics. After the Southwestern Rebellion of 1877, its supporters (Okuma Shigenobu and others) were expelled from the government, which evaded a crisis by promising the establishment of a national diet.

The leadership in the Freedom and People's Rights Movement shifted from the ex-samurai class to the wealthy farmer class, and a movement formed to draft an original constitution; violent uprisings arose in various places between 1881 and 1889. Peace came with the promulgation of the constitution (1889) and, in the following year, the election of Diet members, which was immediately followed by the promulgation of the Imperial Rescript on Education.

The liberating effect of the Meiji Restoration caused ex-samurai and wealthy farmers to question the grounds of the government's legitimacy. One result of the ensuing struggle was the establishment of government control of education and the institution of Shintoism as the state religion and as the principle for education. In response to an inquiry by the Emperor Meiji in 1879, prior to the promulgation of the Imperial Rescript on Education, Motoda Nagazane (1818–1891), a Confucianist, declared in his *Outline of Education* (also called *Imperial Will of Education*) that the "state bureaucracy properly holds the ultimate authority" in education. With the creation of this document came the loss of the power to check "the control by state bureaucrats" (Nagai 1969). The combination of this bureaucratic hegemony in the national education system and the politicization of Shinto became the Achilles' heel of Meiji education.

Seen from another angle, what was occurring was the politicization of bureaucracy. The national Diet was held to the mere status of responding to inquiries and was thus not a legislative body, while the bureaucrats, no longer functioning as administrators, were transformed into a political force, especially those of the Home Affairs Ministry, and began to intervene in education. The Home Affairs Ministry (established in 1873 and abolished in 1947) was the general headquarters of the police administration, which was in charge of maintaining public security and political order. Its ferocious nature peaked in 1928, and this was the time when "maintaining law and order" was used as a pretext for repression and thought control by the "special police."

After the Imperial Rescript on Education, education and most of the country's cultural institutions were made into political institutions, and the age in which "Japan eagerly exerted itself to learn from the West" had ended (Nagai 1969).

Vocational Education and the Normal School System

Although established as a part of the vocational education system, the apprentice schools were unable to fulfil their promise because they were forced to supplement the elementary schools, which were handling only about 50 per cent of the educational needs at the time. Although the schools aimed at transforming skill training under the apprenticeship system that was common to the traditional craft technologies to the cultivation of technical skills under a school system, assiduous efforts by highly talented teachers were required to banish the antipathy that "learning is not necessary for craftsmen" (Sato 1982; Toyoda 1982, 1984). Native technology and industries had to be integrated with modernization.

At the turn of the century, Japanese traditional industry started to fluctuate in parallel with the rise and fall of the modern economy, and modern industry soon began to lead the way. The apprentice school was upgraded from the level of a mere supplement to elementary education to middle-school-level vocational-technical continuation school. It was in these schools that the future leaders in local industries received their educations and training (Toyoda 1982).

As the example of the Seto Ceramics School in Seto indicates, it was due to the efforts of vocational school graduates that traditional industry was successful in adopting modern technology, renovating its management, and advancing into new products, thus transforming itself into an export industry.

It has been generally accepted among Japanese scholars that the apprentice schools and technical continuation schools "did not play an important role as a supplementary educational organization for shop workers" or "did not play any role at all."[51] However, an examination of traditional industry forces a reversal of this evaluation.

The role of the apprentice and technical continuation schools was important especially in regard to the most urgent problems of development, the diffusion of modern technology, and the modernization of traditional industry—particularly in the areas of agriculture, dyeing, commerce, and local industries.

At the beginning of industrialization, military weapons' and other large factories had to establish their own, on-site technology-training centres because they could not depend on the public schools for technology education.

As I mentioned earlier in reference to iron manufacturing, the technology accumulated in this way was usually not transferable to other enterprises or industries. While among low-skill workers there was a tendency to shift from place to place, in highly skilled workers there was a strong tendency to remain in the same place, as the skills were specialized and the pay rather high. Moreover, even with the improvement in technology training in the schools, higher-level technology training and education have continued to the present within each enterprise; this is a peculiarity of Japanese education.

The teachers in the vocational schools had an orientation and personality

that distinguished them from those in the general or elementary schools. As general education became increasingly influenced by politics and the social imbalance brought on by the industrial revolution became more apparent, the economic hardship of the students began to manifest itself in the classroom. The long absences from school and malnutrition forced the teachers to concern themselves with the economic and social solutions of the problems. However, this was regarded as politically dangerous. The more concerned teachers inevitably became more political, and, as a result, were repressed. The vocational school teachers were less involved politically, and had to grope, under the circumstances, for practical solutions to the problems.

Here we are compelled to turn our attention to the normal school and consider the relation between the situation described above and what education scholars refer to as "double-track" or "dual structure" education.

Double-tracking refers to education of an élite to meet the needs of the state and administration on the one hand and commercial and vocational education to meet the requirements of the general population and private sector on the other. An example of the former was the education of technocrats and techno-scientists at Tokyo University; the training of engineers and managers at the industrial and business sites is an example of the latter.

Dual structure, regarded as the "moulder of the Japanese-type of intellectual, describes the particular educational system of the Meiji state, where the degree of coercion of nationalistic education at the elementary level became weaker and the degree of tolerance for liberalism became greater as the level of education rose to secondary education and then to the university.[52] The best example of this was in the university: for an assistant professor to be promoted to the rank of professor, it was essential for him to study abroad, in Europe, or sometimes in China, at the expense of the Ministry of Education. This situation continued until World War II.

Simply put, the desire to throw off the yoke of the unequal treaties and gain an equal footing with the Western powers collided head-on with the determination to forge national unity through the application of state power. These contradictory tendencies were present in the early days of the Meiji regime, but the Rescript gave formal expression to them, and the Ministry of Home Affairs became their voice, while the ministries related to industrial and technological affairs were pushed to the sidelines. Later, the military superseded Home Affairs in the control of education because of corruption by political parties and the pressures of international relations. What had given birth to such self-righteous militarism was the Meiji education system.

The normal school in Japan was developed by Mori Arinori (1847–1889), the first minister of education. Mori, who was so eager as to be almost extreme in carrying out educational reform and development, intended with the normal school to correct the intellectual polarization and imbalance in national education. Consequently, Mori set up his Mori Arinori's Commercial Training School. And yet, despite his pioneering efforts in vocational education, he put the normal school, established to educate teachers to

educate the manpower necessary to build a new nation, under military-style discipline.

This might have been effective, but Mori militarized the normal school in a strange manner. He introduced a network of "secret advisers" and selected one or more "advisers" from each class to report confidentially to the schoolmaster on the daily conduct of fellow students, both in class and in the boarding-house. This appears to be a gloomy contradiction between Mori's ideals and actual practice, but for one involved in the reality of the chaotic society of that day, it might have seemed an inevitable policy.

At the time, freedom was not understood to mean political freedom or the freedom of thought backed by high morals and self-responsibility. It was equated with anarchical self-assertion, egotism exempt from all responsibility. We can see in this a conflict between the "pre-modern" social character of the classes of farmers, craftsmen, and merchants, who had never had a well-developed sense of public duty, apart from family and village, and the "pre-modern" sense of responsibility of the samurai élite, represented by Mori.

The claim is that most commoners who entered the normal schools were farmers, but this is debatable. From a sociological viewpoint, the peculiar manner of personality formation in the normal school does not seem to have been one that would relate to farmers (especially the landowner-farmer class) but more closely to the ruined samurai class. Indeed, it is my opinion that the low-ranking samurai—thrown into extremely poor conditions as a result of their resistance to the new government—maintained their traditional code of loyalty, changing only the object from the old shogunate to the new government.

Because power under the Tokugawa shogunate had long been consolidated, the samurai was no longer a warrior but an administrative bureaucrat, and his adaptability to altered circumstances was quick. And yet, the unstable status of teachers and their surprisingly low salaries, combined with the ex-samurais' sense of social superiority, caused them to feel resentment.

The rank of non-commissioned officer in the Japanese army, the epitome of inhumanity and impersonality, had something in common with the frustrated and grotesque personality formation among the ruined samurai at the Meiji normal school. In the military, soldiers who were graduates of middle or higher schools were brutalized in the name of the Emperor by the less-educated non-commissioned officers.

Similarly, in the schools, pupils from uninfluential and unpropertied familes were mistreated by teachers educated at normal schools, while the students of rich or influential families wre treated well in an attempt to gain favour and effect improvement in the teachers' own positions.

The common element in the mentality of these lower-level bureaucrats was their conciliatory approach to subordinate personnel or pupils who displayed any disobedience or resistance. The reason for this was that the presence of this sort of defiance was enough to jeopardize the position of the teachers of these trouble-makers: any advantage the teachers may have had in the com-

petition for loyalty could be lost. They tried to conceal the existence of any unique or unusual elements in their surroundings.

Late-Comer Investment in Education

As Hamao Arata (1849–1925), an enlightened bureaucrat, said in his address at the inauguration ceremony of the Tokyo Worker Training School in 1881: "In this country . . . our policy is not to establish factories and then set up technical schools to supply them, but to establish technical schools and send their graduates out to set up the factories." This is a clear example of the determination to give priority to the development of human resources at the initial stage of industrialization.

The first graduates from the Tokyo Worker Training School numbered 24, among which, however, only 3 could find jobs after graduation.

Obviously, the demand for science and engineering expertise was low. Similarly, there were few seeking this sort of training. Take the case of Niijima Yuzuru, who had planned to establish a science and engineering institute, but had to abandon his plan because of insufficient applicants. Because of the recently promulgated official medical licencing system, medical and pharmaceutical schools were the few exceptions that had applicants, though the number was reportedly small.

After World War I, however, the need for science and engineering departments had grown to the extent that they began to be established in the private schools. This was at a time when Japanese technology had achieved a primary stage in self-reliance, and the demand for science and engineering experts was consequently much greater. The national universities had taken the lead in this simply because they could easily meet the small need that had existed until this time.[53]

The advocacy for development of human resources by investment in higher education was made also by Sano Tsunetame (1822–1902), a politician, and Yamao Yozo (1837–1917), an enlightened engineer. They were themselves the product of human resource development policies undertaken by feudal clans at the end of the Tokugawa shogunate. They advocated an expansion—beyond the old political boundaries of feudal clans—to a national scale of the development of human resources. The Meiji government's development policy, the "encouragement of industry," was thus not an idea that originated with the new government, but an enlargement on a nation-wide scale and a centralized development of the earlier experiences in the former feudal clans.

However, investment in higher education was fragmented and unsystematic at first. Each ministry had, under its supervision, its own institution for recruiting and developing needed manpower. By 1878, the tenth year of Meiji, these schools (the "seven peaks competing for the development of manpower")[54] under the direct control of the various ministries consisted of: the School of Engineering under the Ministry of Works; the University of Tokyo (a unification of the former Kaisei School and the Medical College)

under the Ministry of Education; the School of Law under the Ministry of Justice; the Sapporo School of Agriculture under the Ministry of Development of Hokkaido; the Komaba School of Agriculture under the Ministry of Home Affairs; the Military Academy; and the Naval Academy.

In 1886, the imperial universities were established, and the University of Tokyo absorbed the School of Engineering and Komaba School of Agriculture (the Sapporo School of Agriculture came under the control of the Ministry of Education in 1895). Universities both in name and reality were established. A comparison with universities in Europe, whose long traditions go back to the Middle Ages, reveals the secularist nature of Japanese universities.

Various Buddhist sects had had their own seminaries for priests since the seventh century, but they were outside the education policy of the Meiji government. And there were private professional institutions of Shintoism that engaged in activities not found in the neutral departments of religious studies in the imperial universities. This was a paradox of the Meiji educational system and a remarkable indication of the conformity (recalling that the Meiji government had made Shintoism the state religion) in most Japanese private institutions to the current political orientation.

Tokyo Imperial University became "the first university in the world, excepting the United States, that included a college of engineering" (Nagai 1982).[55] Nevertheless, its emphasis was on building up its faculty of law, which was the nursery for bureaucrats in the state administration.

Its graduates could be referred to as "social engineers"; they were modernizers, aiming to upgrade society based on a new, Western-oriented value system, rather than intellectuals devoted to academic inquiry and the creation of new values. However, in the first half of the Meiji era, jurisprudence had an enlightened nature different from that existing today in Japan; it supplied men through whom the rule of law and the maintenance of order by law became actualized on a broad scale, and there was a great concern with international law. During the Russo-Japanese War, scholars of international law were posted at the headquarters in the forefront of battle. Although this was nothing but a precautionary measure that a small late-comer nation had to take under the restrictions of the unequal treaties, it is noteworthy that there was such a monitoring system. It was after Japan won the Sino-Japanese and the Russo-Japanese wars and revised the unequal treaties that such checks stopped functioning.

It is noteworthy that the imperial universities had agriculture departments besides their departments of medical science, science, and engineering. This reveals the pragmatic nature of universities of those days.

Apart from the imperial universities, and even before their establishment, it was apparent to policy makers and the few techno-scientists who were in existence that there was a national need for engineers. The Tokyo Worker Training School was at the forefront in the efforts to accumulate international science and technology information, draw up science and engineering policies, and create a fund of trained personnel. It developed manpower for

manufacturing and trained engineers who could supply the needed technological support and leadership.

The Tokyo Worker Training School (which became the Tokyo Institute of Technology) was established in 1881, offering a one-year preparatory course and a three-year regular course, as an institution of technology training for developing future vocational school teachers, plant foremen, and floor supervisors.

This school became the model of practical education and the prototype for the elementary and higher vocational training institutions established throughout Japan. It also became the supply source of teachers for those schools. And, because of the great shortage of qualified teachers, graduates from the school were able, through the alumni association, to teach in a variety of places, and, as each move meant a promotion, they also won a steady rise in social status.

The traditional label *shokunin* (craftsman) yielded to the more current-sounding *shokko* (workman). More than "factory worker" it referred to the artisan or manager armed with new technology, the educated professional of modern technology.

The Tokyo Worker Training School had an apprentice school under it and was later transformed into first a technical school, then a higher technical school, and finally the present institute of technology. It came to be referred to as the MIT of Japan. Even bureaucrats such as Inoue Kowashi (1834–1895), who was eager for a vocational education system for industry, and though there was no shortage of funds once the necessary legislation was in place, could not have achieved this had it not been for the school's enterprising leader, Tejima Seiichi (1849–1918), who regarded industrial education as his mission.

Tejima established himself as a great educator because he "enlarged the concept of technical schooling to mean industrial education" (Miyoshi 1983). Without his personality and philosophy, the founding of the institute would not have materialized.

However, in the beginning, education in industrial technology was not the main part of vocational training. The agricultural school had the largest number of pupils, followed by the commercial school. Each had developed in connection with traditional local industry. As for the overall structure, there were high schools of agriculture and forestry, of commerce and of industry, and these were then organized into colleges that specialized in each field of technology. This was in parallel with the system of middle school, high school, and imperial universities. These two systems were completed between the 1910s and 1920s, exactly the time when the national formation of a technology network, the first stage of self-reliance in technology, was accomplished.

It should also be noted that Tejima and others set the starting point for vocational education at the level of elementary school. Tejima successfully introduced manual arts and handicraft training into elementary school curriculums. He understood that skill training was an indispensable part of

successful technology development and transfer. Because of the long time required to develop skills, it is necessary and important that their cultivation be started at the elementary school level. This conviction on the part of Tejima and his colleagues was in contrast to the situation in Great Britain, where vocational education was merely one measure to relieve the poor and the relation between technology and skill was overlooked.

Because Japan is a monolingual society, questions of terminology and language do not occur regarding science, mathematics, drafting, and manual arts education in the schools. In a multilingual society, however, there may be difficulties and much debate over the terminology of science and technology (and the language of instruction), not only in regards to the elementary school level, if such education begins there, but even at the high school level too. We have pointed out the importance of native engineers to a nation's technological self-reliance, and we are fearful that education in science and technology in a foreign language might create an obstacle. Using foreign-language texts at the initial stage of education in technology might be unavoidable, but it is not wise to impose the mastery of a foreign language on engineering students at every stage.

"Of the major tasks in education—textbooks and methods of training teachers, for example—undertaken in Japan at the beginning of the Meiji period, nothing was worked out or designed by the Japanese themselves" (Nagai 1982). This was the reason the attendance rates did not reach 50 per cent for more than 20 years. Even the text used in the Japanese language classes was a translation of the Wilson reader from the United States. Under such circumstances, when education does not relate to a people's daily life and culture, it will not be viable. Many excellent translations and adaptations of children's stories, folk songs, and similar works could be mistaken, even today, for original Japanese works; but these examples represent exceptional cases, and demonstrate that only those adaptable to the everyday life of the people and to the national culture will survive. Japan endeavoured to cull such works for more than 20 years.

Although not directly connected with education in science and technology, the compilation of a national language dictionary was a great undertaking in Japan from the standpoint of national education. In the twenty-fourth year of the establishment of the new Meiji government, Otsuki Fumihiko (1847–1928) completed the first modern Japanese language dictionary, the *Genkai*.[56]

Regarding the diffusion and development of education, Nagai (1982) states that "when power from outside and above was added to change from inside and below, Japanese education was modernized for the first time, which was characteristic of an underdeveloped country."

Our research on development and education has stressed "change from below" and regional effects. What Nagai calls the modernization of education we interpret as the "popularization of education." In fact, modernization should be the same as popularization. After the bitter experience of "ultra-nationalism in education," the Japanese began to believe that the

modernization of education should be an activity for national development based on the firm principles of democracy and peace, but with the flexibility to adjust to the changing international setting. In this sense, Japan has not yet completed its modernization of education; the state continues to control education for use in serving its own needs.

On-Site Training

At the initial stage of industrialization, when there was a small group of techno-scientists and engineers on the one hand and a great many unskilled and unemployed workers on the other, some of the skilled technicians took on apprentices and thus attempted to bridge this gap. The apprentice system was seen, therefore, not only in traditional industry but also in big, modern factories.

However, these masters and their apprentices were unfamiliar with completely new technology and skill areas, and skill formation required education and training. To meet this requirement, training centres were established within each enterprise or factory.

At the apprentice school and the technical continuation school, training was separated into study and practical application (no such distinction had existed in the apprenticeship system), and instruction was by engineering experts. There was a significant difference between skilled labour trained through apprenticeship at the time when elementary education was not widespread and those who were trained in the factory training centres or in middle schools. The education effects were evident in the latter group, whose workers had gained an awareness of the logic of technology hidden in the empirical reality.

The basic training for Japan's special brand of engineer was received in the schools established within each enterprise—equivalent to secondary education—and through the vocational education system. This training was far from complete, but the long process of skill formation got its start there. Not only the leading engineers of big enterprises but also the craftsmen who pioneered the technological progress in the traditional industries were trained under this vocational education system.

When the inner and outer links of technology had been established on a nation-wide scale, these vocational schools were upgraded to colleges. For students who had worked their way up through vocational school, technical school, and then college, the college course work consisted of mainly subjects not directly related to their technical specializations, such as a second foreign language, and, as they had by this time already gained a firm grounding in the core technical fields, they could turn their attention to these other subjects. In other words, the college started supplying "educated professionals." Besides bankers, for example, the Tokyo University of Commerce also graduated diplomats.

In 1908, Tokyo Imperial University began offering an economics course in

its faculty of law; it introduced a commerce course in 1909, and newly established the faculty of economics in 1919. Here, professional education from above and from below intersected. In 1920, the Yokohama Technical College (currently the Faculty of Engineering of Yokohama National University) was established and a unique system of no examinations and no marking adopted. Contrary to what one might expect, the system did not encourage idleness and the students received high evaluations. It was a symbolic event in the most liberal age of education.

The question of education in Japan was very often the subject of our discussions, and many cases in which Japan had been misunderstood were rooted in an overestimation of the education system and national policy toward education. In truth, the most important elements were the shop-floor training in the formation of skills and the training of engineers on the basis of general education.